Every Student Counts

Professional Development Guide
Middle School Level

Year 1 - Day 1

Iowa Department of Education

Middle School Session –Facilitator Plan
Year 1 - Day 1

Content Goal:
NCTM Algebra Standards
Understand patterns, relations, and functions

Process Focus:
Representation
Create and use representations to organize, record, and communicate mathematical ideas

Overall Teaching Goal: Teaching and learning mathematics through problem solving

Activity	Description for Facilitator	Time (Min)	Teacher Masters (TM) & Materials
1. Welcome and Opening Activity	Get Acquainted Activity: "Yes/No"	15	**TM 1:** "Yes/No" Response Sheet • Index Cards
2. Overview	Outline of year one Overview of day one Readings Discussion Algebra Standard PSSM pg 37 – 40 Representation Standard PSSM pp. 67 - 71	20	**TM 2:** Year One Outline **TM 3:** Daily Overview **TM 4:** Year 1 Day 1 Agenda • Principles and Standards for School Mathematics (PSSM) • PSSM Quick Reference Guide
3. Problem-Based Instructional Task	Understanding Problem-Based Instructional Tasks Understanding pattern development and using a table	40	**TM 5**: Exploring Houses sheet (p. 74 in Navigating through Algebra in Grades 6 – 8 **TM 6**: PBIT Components **TM 7**: PBIT Lesson Plan – Exploring Houses • Pattern Blocks • Graphing Calculator • Graph Paper
4. Meaningful Distributed Practice	Understanding Meaningful Distributed Practice (MDP) Examination of components of Meaningful Distributed Practice Modeling MDP	30	**TM 8**:Meaningful Distributed Practice (MDP) Research **TM 9**: MDP Components **TM 10**: MDP Explanation **TM 11**: Function Machine **TM 12**: MDP Activities • TeachTimer • Overhead pen

<table>
<tr><th>Activity</th><th>Description for Facilitator</th><th>Time (Min)</th><th>Teacher Masters (TM) & Materials</th></tr>
<tr>
<td>5. Data Collection Stations</td>
<td>Participation in Problem-Based Instructional Task
Rotation through several data collection stations</td>
<td>80</td>
<td>TM 13: Five Representations of a Function
TM 14: Directions for Data Collection Stations
TM 15: Data Collection Stations (DS)
TM 16: DS material: M and M Mapping
• Graph Paper
• Graphing Calculator – regular and overhead
• Overhead transparency sheets – blank
• Overhead pens
TM 17: Ten Stations Assignments
<table>
<tr><th>Data Station (DS) Materials</th></tr>
<tr><td>DS: Balls - two types</td></tr>
<tr><td>DS: Circular Items - 8</td></tr>
<tr><td>DS: Crumpled paper - 10</td></tr>
<tr><td>DS: Cup</td></tr>
<tr><td>DS: M & M's - 25</td></tr>
<tr><td>DS: Masking Tape</td></tr>
<tr><td>DS: Meter sticks</td></tr>
<tr><td>DS: Pan balances - 2 or 3</td></tr>
<tr><td>DS: Peanut M & M's - 116</td></tr>
<tr><td>DS: Pennies - 100</td></tr>
<tr><td>DS: Plate</td></tr>
<tr><td>DS: Sandwich bags</td></tr>
<tr><td>DS: Skittles - 160</td></tr>
<tr><td>DS: Springs which easily stretch (or rubber bands)</td></tr>
<tr><td>DS: stop watch</td></tr>
<tr><td>DS: String - one meter long</td></tr>
<tr><td>DS: tape measures</td></tr>
<tr><td>DS: Tape measures</td></tr>
<tr><td>DS: Tiles (or dominoes) 100</td></tr>
<tr><td>DS: Waste baskets</td></tr>
<tr><td>DS: Weights - gram or ounce</td></tr>
<tr><td>DS: Weights to attach to string</td></tr>
</table>
</td>
</tr>
</table>

Activity	Description for Facilitator	Time (Min)	Teacher Masters (TM) & Materials
6. Problem-based Instructional Task Modeled	PBIT example provided. MMM Video of "Trashketball" designed as a student-centered lesson	100	• Modeling Middle School mathematics video, Trashketball • Internet Connection for MMM **TM 18**: Response Form for Trashketball video **TM 19:** Lesson Plan for Trashketball **TM 20:** Poster Session with Carousel Sharing
7. Closure	Assignments Evaluation	15	**TM 21:** Assignment Sheet • Evaluation Form

Facilitator's Tool for Planning the Session

What is the background reading?

What equipment and materials should **participants** bring?

What Teaching Masters need to be copied?

Handouts

TM 1: "Yes/No" Response Sheet

TM 2: Year One Outline

TM 4: Year 1 Day 1 Agenda

TM 5: Exploring Houses sheet (p. 74 in Navigating through Algebra in Grades 6 – 8

TM 6: PBIT Components

TM 7: PBIT Lesson Plan – Exploring Houses

TM 8: Meaningful Distributed Practice (MDP) Research

TM 9: MDP Components

TM 10: MDP Explanation

TM 11: Function Machine

TM 12: MDP Activities

TM 13: Five Representations of a Function

TM 14: Directions for Data Collection Stations

Handouts

TM 15: Data Collection Stations

TM 16: M and M Mapping (several for station)

TM 17: Ten Stations Assignments (several, copied then cut in thirds)

TM 18: Response Form for Trashketball video

TM 19: Lesson Plan for Trashketball

TM 20: Poster Session with Carousel Sharing

TM 21: Assignment Sheet

Overhead (or copy if overhead display equipment available):

TM 3: Daily Overview

TM 5: Exploring Houses sheet (p. 74 in Navigating through Algebra in Grades 6 – 8

TM 6: PBIT Components

TM 8: Meaningful Distributed Practice (MDP) Research

TM 9: MDP Components

TM 11: Function Machine

TM 12: MDP Activities

TM 13: Five Representations of a Function

TM 18: Response Form for Trashketball video

TM 20: Poster Session with Carousel Sharing

What other teaching supplies/materials/technologies are needed?

What other teaching supplies/materials/technologies are needed?

- Evaluation Form
- Graph Paper
- Graph Paper
- Graphing Calculator
- Graphing Calculator – regular and overhead
- Index Cards
- Internet Connection for MMM

What other teaching supplies/materials/technologies are needed?

- Modeling Middle School mathematics video, *Trashketball*
- Overhead pens
- Overhead transparency sheets – blank
- Pattern Blocks
- Principles and Standards for School Mathematics (PSSM)
- PSSM Quick Reference Guide
- TeachTimer

Data Stations (DS): Balls - two types

DS : Circular Items - 8

DS : String - one meter long

DS : Tape measures

DS: Crumpled paper - 10

DS: Cup

DS: M & M's - 25

DS: Masking Tape

DS: Meter sticks

DS: Pan balances - 2 or 3

DS: Peanut M & M's - 116

DS: Pennies - 100

DS: Plate

DS: Sandwich bags

DS: Skittles - 160

DS: Springs which easily stretch (or rubber bands)

DS: stop watch

DS: tape measures

DS: Tiles (or dominoes) 100

DS: Waste baskets

DS: Weights to attach to string

DS:: Weights - gram or ounce

Activity 1: Welcome and Opening Activity

Time: 15 minutes

Overview and Rationale

This activity allows participants to get to know each other and provides some interesting data for discussion.

Connections

This activity sets the stage for a student-centered day.

Conducting the Activity

Grouping

Participants will be rotating through partners throughout this activity.

Introduction

- Participants write "Yes" on one side of an index card and "No" on the other side.
- Describe the activity and the response sheet TM 1.
- Participants pick a partner (preferably one they don't know), pick a question from TM 1. Circle the number of the question they are answering, so they don't try to answer it again.
- For each statement, each person in the pair should hold up the answer they feel is correct for them individually. They then discuss the statement and determine who correctly responded (it could be both). Correct responses are marked in the square with a check.
- Participants then find a different partner and follow the steps above with a different question.
- Participants continue until they have talked about all the questions with someone.

Closure

Discussion can be held regarding some of the items with the most interest. Listen to some of the comments during the individual discussions and select several to share. In particular, the items that involve numerical data provide the best lead in to the day's activities. Those might include number of states visited, number of books read, and/or farthest birth place.

Materials

TM 1: "Yes/No" Response Sheet

- Index Cards

TM-1

Yes – No Response Sheet

Name _____

1. I was born farther from here than you. ☐
2. My birthday is closer to the summer solstice than yours. ☐
3. My eldest grandparent lived longer than any of yours. ☐
4. In the last year, I have attended more sporting events and concerts than you have. ☐
5. I have taken more mathematics courses than you have. ☐
6. I spend more money on clothes each year than you do. ☐
7. I have read more books for pleasure in the last year than you have. ☐
8. I have visited more U.S. States than you have. ☐
9. I have had more pets in my life than you have. ☐
10. I have memorized more poems/songs than you have. ☐

Activity 2: Overview

Time: 20 minutes

Overview and Rationale:
This activity sets the stage for the year and the day.

Connections:
This section will provide an opportunity to relate daily activities to the year-long goals and activities.

Conducting the Activity:

1 Year 1 Outline Chart TM 2
- Remind participants of the big picture for the year.
- Point out where we've been and where we're going.
- Emphasize the focus on NCTM Content Standards and Process Standards.

2 Go through Year 1 Day 1 Agenda TM 4 handout while using the Day 1 Overview Chart TM 3
- Briefly go through agenda
- Remind participants of the main themes of Every Student Counts: Teaching for Understanding, Problem-Based Instructional Tasks, and Meaningful Distributed Practice.
- Point out how those themes will be applied to the two focus points for Day 1: Algebraic patterns, relations, and functions and representation.
- Use the Quick Reference Guide to locate the NCTM Standards being highlighted.
- Point out that Activity 1 is already complete .

3 Read and discuss Process Standard
- Participants read PSSM Representation Process Standard (pp. 67 – 71).
- Participants discuss at table the impact teaching to the Representation Process standard will have on Curriculum, Instruction, and Assessment (CIA.)
- Share a few ideas from each team with the whole group.

Materials:
TM 2: Year One Outline
TM 3: Daily Overview
TM 4: Year 1 Day 1 Agenda
- Principles and Standards for School Mathematics (PSSM)
- PSSM Quick Reference Guide

TM-2

Year One Outline
2004-2005

	Day 1 September 14/15	Day 2 October 26/27	Day 3 February 1/2	Day 4 April 26/27
NCTM Content Standard	Algebra	Algebra	Algebra	Algebra
	Understand patterns, relations, and functions	Understand patterns and functions	Represent and analyze mathematical situations and structures using algebraic symbols	Represent and analyze mathematical situations and structures using algebraic symbols
NCTM Content Standard 2		Algebra		Algebra
		Represent and analyze mathematical situations and structures using algebraic symbols		Analyze change in various contexts
Mathematical Activities	Represent, analyze, and generalize patterns with tables, graphs, words, symbolic rules Relate and compare different representations for relationships Explore linear and nonlinear functions	Relating data and building goals to distributed practice Distributed Practice Development Patterns and Functions Sharing data collection station activities Standards-based mathematics classroom	Problem solving relating algebra to concrete representations Modeling and Solving Problems using Technology	Discuss Working Inside the Black Box Representing and Analyzing mathematical situations using symbols Special Education connections Modeling and Solving Problems using Technology
NCTM Process Standard	Representation	Connections	Reasoning and Proof	Problem Solving
Assessment		Review post-test data		Working Inside the Black Box
Technology/ Manipulative Tools		VCR	Graphing Calculator	Graphing Calculator

TM-3

Every Student Counts means . . .

Teach for Understanding
and
Focus on Meaning

Problem-Based Instructional Tasks &
Teaching through Problem Solving

Meaningful Distributed Practice of Concepts, Skills, and Problem Solving

Today's Goals . . .

Content Goal: Algebra
Process Goal: Representation

Today's Objectives . . .

- *Understand patterns, relations, and functions*
- *Create and use representations to organize, record, and communicate mathematical ideas*

TM-4

Year 1 Day 1 Agenda

Goals: Algebra Content Standard
Representation Process Standard

Objectives:

- Understand patterns, relations and functions
  - Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and when possible, symbolic rules
  - Identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations
- Create and use representations to organize, record, and communicate mathematical ideas

Activities:

1 Opening Activity

2 Overview
- Overview of year
- Overview of Day One
- Reading Discussion

3 Problem-Based Instructional Task
- Exploring Houses

4 Meaningful Distributed Practice

5 Data Stations
- Data Collection Activity
- Debrief data activity

6 Problem-Based Instructional Task Modeled
- Trashketball
- Lesson Planning of Data Station by grade level
- Carousel Sharing

7 Closure
- Reflecting on the day
- Assignments and Evaluation

Assignments:

- Collaborate with peer partner to refine data station PBIT lesson plan, teach the lesson and reflect on student understanding. Bring five copies of lesson plan to share.
- Bring selected student work (one representing a low level student response, one middle and one high level student response) from data station PBIT. Bring five copies of each student response level.
- Read about connections (PSSM pp. 274 - 279 and pp. 64 – 66)
- Read Teacher Story 5 (Green problem solving book, pp. 219 – 225)

Activity 3: Problem-Based Instructional Task

Time: 40 minutes

Overview and Rationale:

This activity will use an algebra task to illustrate to teachers the components of a Problem-Based Instructional Task.

Connections

This activity is in NCTM *Navigating through Algebra in Grades 6 – 8*, on pages 9 – 12. Advance reading material for this task is on pages 1 – 5 and 7 – 8. The CD-Rom that comes with the book has readings and copies of all the blackline masters. One of the readings, "Listening to Middle School Students' Algebraic Thinking" would be an appropriate reading before beginning this activity with students.

Conducting the Activity

- **Task**
  - "Exploring Houses" – pages 9 through 12 in *Navigating through Algebra in Grades 6 – 8.*
  - Participants begin individually building houses shown on teaching master TM 5 and answering the questions. (Observe thinking during this time).
  - After solving independently, work in teams of three or four to finish TM 5.
  - After teams have had time to work on problem, share solutions in large group. Try to have several solutions described.

- **Problem-Based Instructional Task**
  - At each table, participants examine the components of Problem-based Instructional Tasks TM 6.
  - Determine which components were present in the "Exploring Houses" task they just completed.
  - Share copy of lesson plan TM 7.
  - Emphasize components of lesson plan
    - Emphasize launch, Explore, Summarize as ways to build a Problem-Based Instructional task.
    - Point out formative assessment
    - Point out that reflection takes place after lesson taught.

Materials

TM 5: Exploring Houses sheet (p. 74 in Navigating through Algebra in Grades 6 – 8
TM 6: PBIT Components
TM 7: PBIT Lesson Plan – Exploring Houses

- Pattern Blocks
- Graphing Calculator
- Graph Paper

TM- 6

PROBLEM-BASED INSTRUCTIONAL TASKS

- Help students develop a deep understanding of important mathematics
- Are accessible yet challenging to all students
- Encourage student engagement and communication
- Can be solved in several ways
- Encourage the use of connected multiple representations
- Encourage appropriate use of intellectual, physical and technological tools

TM-7

PROBLEM-BASED INSTRUCTIONAL TASK LESSON PLAN

OBJECTIVE/BENCHMARK:
Understanding pattern development
Using a table to organize information
Choosing a strategy (e.g. draw a picture, use recursion, write an explicit rule) to make a prediction.

TITLE: Exploring Houses

GRADE LEVEL/COURSE: Middle School

PRE-REQUISITE KNOWLEDGE:

NCTM STANDARD(S): (Shaded)

NCTM Content Standards →	Number & Operations	Algebra	Geometry	Measurement	Data Analysis & Probability
NCTM Process Standards →	Problem Solving	Reasoning & Proof	Communication	Connections	Representation

MATERIALS NEEDED:

Audio-visual:
Manipulatives/Materials: Copy of Teaching Master "Exploring Houses" for each student
Pattern blocks (at least 10 triangles and 20 squares per student)
Literature:
Technology/Software: Graphing calculator (optional)
Other:

MAIN LESSON DEVELOPMENT:

- **Launch**
  This activity is in *Navigating through Algebra in Grades 6 – 8*, on pages 9 – 12. Participants will build 4 houses based on design illustrated on teaching master. They will predict the total number of pieces needed to build any house in the sequence.
- **Explore**
  Participants explore increasingly larger houses. They arrange their information in some way to help predict house 15. Participants work with their partners to write a rule that gives the total number of pieces needed to build any house in the sequence.
- **Summarize**
  Participants share their solutions. As student explain how they determined the pattern, take note of their strategies. Help them describe their rule in words and symbols.

MODIFICATIONS/EXTENSIONS:

- **Modifications**
  - This activity is a Problem-Based Instructional Task that allows students from several ability levels to explore patterns
- **Extensions**
  - Ask students to use only the squares and to find a rule for the perimeter of the figures
  - Use another growing pattern illustrated on page 10.
  - Have students use the graphing calculator to enter data, look at the scatter plot and find the line of best fit.
  - Use this problem to identify the different terms in a linear equation as they relate to the model

CHECKING FOR UNDERSTANDING (FORMATIVE ASSESSMENT)

- **What will you assess?**
  - Understanding pattern development
  - Using a table to organize information
  - Choosing a strategy (e.g. draw a picture, use recursion, write an explicit rule) to make a prediction.)
- **How will you assess it?**
  - After working independently, students will share their results. Teachers will observe how students communicate their reasoning and strategies
  - Students can turn in personal solutions for individual accountability

---------- (REFLECTION AFTER TEACHING THE LESSON) ----------

- **How did the students perform?**
- **How will you use this information to guide future instructional decisions?**

Activity 4: Meaningful Distributed Practice (MDP)

Time: 30 minutes

Overview and Rationale

This activity provides examples and discussion of Meaningful Distributed Practice. Meaningful Distributed Practice is one of the main components of the Every Student Counts program, along with teaching for understanding and problem-based instructional tasks.

Connections

In the classroom, this would generally be the first activity of the day by the teachers.

Conducting the Activity

Introduction

- Introduce MDP by using the research teaching master TM 8.
- Review the components of MDP with component teaching master TM 9.
- Discuss TM 10, the detailed definition of MDP – italics have been added to emphasize the key components. Remind participants that MDP should not last longer than 5 minutes. If manipulatives are used, it should be the teacher who uses them on the overhead. The purpose is to develop concepts, skills and problem-solving. It is NOT meant as an opportunity to drill skills. That type of practice could take place at another time, but it is not MDP.
- Model a MDP activity using the function machine on TM 11 or use virtual function machines at websites that have a online function machines:
  - http://www.amblesideprimary.com/ambleweb/mentalmaths/functionmachines.html .
  - http://nlvm.usu.edu/en/nav/frames_asid_191_g_3_t_1.html
- Set a timer to show the activity can take place in 5 minutes and still address conceptual development
- Have a brief discussion of why these problems are examples of Meaningful Distributed Practice referring back to TM 8.

Materials

TM 8: Meaningful Distributed Practice (MDP) Research
TM 9: MDP Components
TM 10: MDP Explanation
TM 11: Function Machine
TM 12: MDP Activities

- TeachTimer
- Overhead pen

TM-8

Distributed Practice of Concepts, Skills and Problem Solving

Meaningful Distributed Practice is consistent practice distributed over a long period of time

Research Rationale:

"Long term retention is best served if assignments . . . are spread out in time rather than concentrated within a short interval."
(Suydam, et. Al.)

TM- 9

Meaningful Distributed Practice of Concepts, Skills and Problem-Solving

- Targets an identified need based on multiple data sources
- Helps students develop a deep understanding of a *Big Idea*
- Helps students develop flexibility and fluency with skills and concepts
- Builds on and extends understanding
- Uses problems and activities that help students learn to use multiple representations, and learn to use multiple reasoning strategies
- Uses problems from a variety of contexts so students learn to make connections.

TM-10

Explanation of Meaningful Distributed Practice of Concepts, Skills and Problem Solving

What is the Research Rationale?

Long-term retention is best served if assignments are spread out in time rather than concentrated within short intervals.
(Iowa Content Network, (http://www.state.ia.us/educate/ecese/tqt/tc/prodev/mathematics.html)

What Does Meaningful Distributed Practice for Concepts and Problem Solving Look Like?

Distributed practice is *consistent* practice distributed over a *long period of time*. It can be presented in *brief* (about five minutes) problem solving and/or conceptual activities *three to five times a week* throughout the school year. These instructional activities should reinforce the *BIG IDEA* that you have chosen for your building improvement plan for Every Student Counts. The problems and activities that you use for distributed practice should be chosen to *help students develop a deep understanding of that BIG IDEA*.

These problems and activities should be *student-centered*, in the sense that the students derive their own ways to model, to reason with, and to explain the problems.
The problems and activities should:

- Include a *variety of connections to real-world situations*
- Encourage the use of a *variety of models or representations*
- Allow for a *variety of reasoning or solution strategies*.

Ask for *two, or possibly three, explanations* of the problem. *Summarize* by briefly highlighting the *different representations and reasoning strategies* that were used.

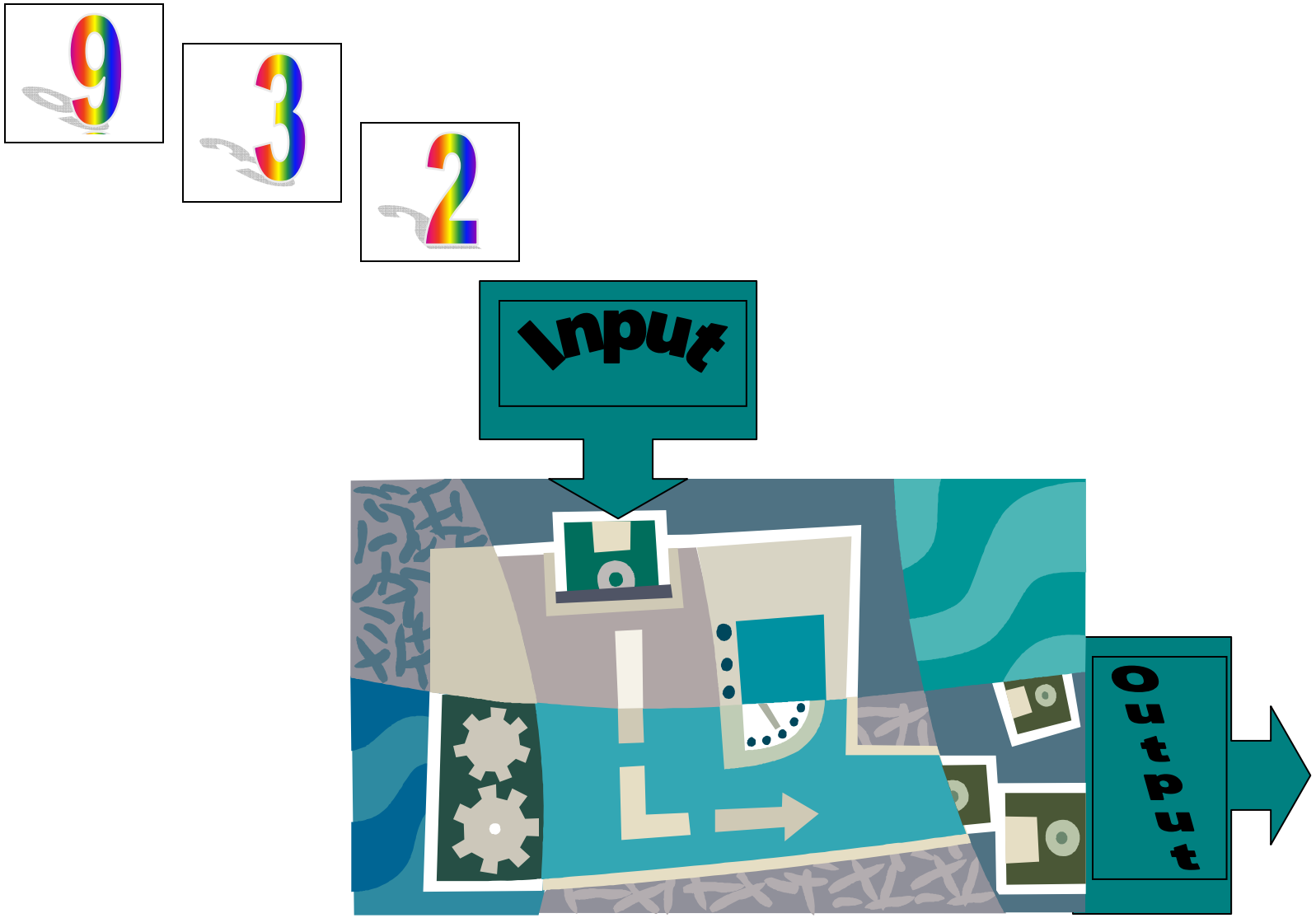
What are the *Purposes* of Meaningful Distributed Practice?

- To help students develop a deep understanding of a ***BIG IDEA***
- To address important weak skills on Iowa tests
- To pre-teach skills necessary for a new concept coming up
- To allow students more time with a difficult concept
- To expose students to multiple representations
- To show students the many contexts in which math is used

Problems and activities should help students learn to use *multiple representations*, and learn to use *multiple reasoning strategies* with such deep understandings that they can use the representations and reasoning *flexibly and fluently*. In addition, by using problems from a variety of contexts, the students should learn when it makes sense to *apply* this BIG IDEA in *everyday life*

TM- 11

FUNCTION MACHINE



TM- 12

Meaningful Distributed Practice Activities

- Prepare a function machine for your students.

- Give one student a rule, (e.g. 4 x – 3.)
  - Input a number and have the student apply the formula and output the answer.
  - Put in 2, then 5 comes out.
  - Ask students to determine the rule. Any rule will work provided an input of 2 yields an output of 5.
  - Ask for possible rules from the class and write them on the board.
- Now input 3. Have the student determine the output 9.
  - Make a table and in one column write "input" and the second column, "output".
  - List 2 and 3 in the input column and 5 and 9 in the output column, next to the appropriate inputs.
- Provide one more input 4 and the associated output 13.
  - Write those numbers in the table.
  - Now have the students determine the rule. It must work for all the inputs and outputs.
- Ask students to share how they determined the rule. Listen for misconceptions and for good problem-solving.

Activity 5: Data Collection Activity - Ten Data Collection Stations

Time: 80 minutes

Overview and Rational

During this day's focus on representing algebraic functions graphically, data is collected from ten separate stations. The data is displayed on tables and graphs. Participants then share results and graphing procedures.

Connection to Other Activities and the Whole Day

This activity begins the day's algebra activities. It emphasizes the various representations possible demonstrated in the algebraic pentagon TM 13. This activity will be complemented with the classroom vignette, *Thrashketball,* and the Problem-based Instructional Task creation activity.

Conducting the Activity

- Groups of three or four are formed with at least one person with middle school mathematics preparation in each group.
- A detailed description of the materials needed, the set-up and purpose of the stations can be found in TM 14. Participants receive a brief description TM 15 and the assignment sheet TM 17.
- Describe the various stations, the setup in the room, and the assignment. All groups circulate throughout the room gathering and recording data from as many stations as they can in the allotted time. It depends on number of participants and amount of time available, but if the number of stations changes, TM 17 needs to be changed.
- Groups choose at least three stations to work.
- The groups go back to their tables and prepare a transparency of one of the graphs.
- Circulate and select 3 or 4 of the graphs to share with the whole group.
- A lesson will be developed as part of activity 6.

Materials:

TM 13: Five Representations of a Function
TM 14: Directions for Data Collection Stations
TM 15: Data Collection Stations
TM 16: DS material: M and M Mapping

- Graph Paper
- Graphing Calculator – regular and overhead
- Overhead transparency sheets – blank
- Overhead pens

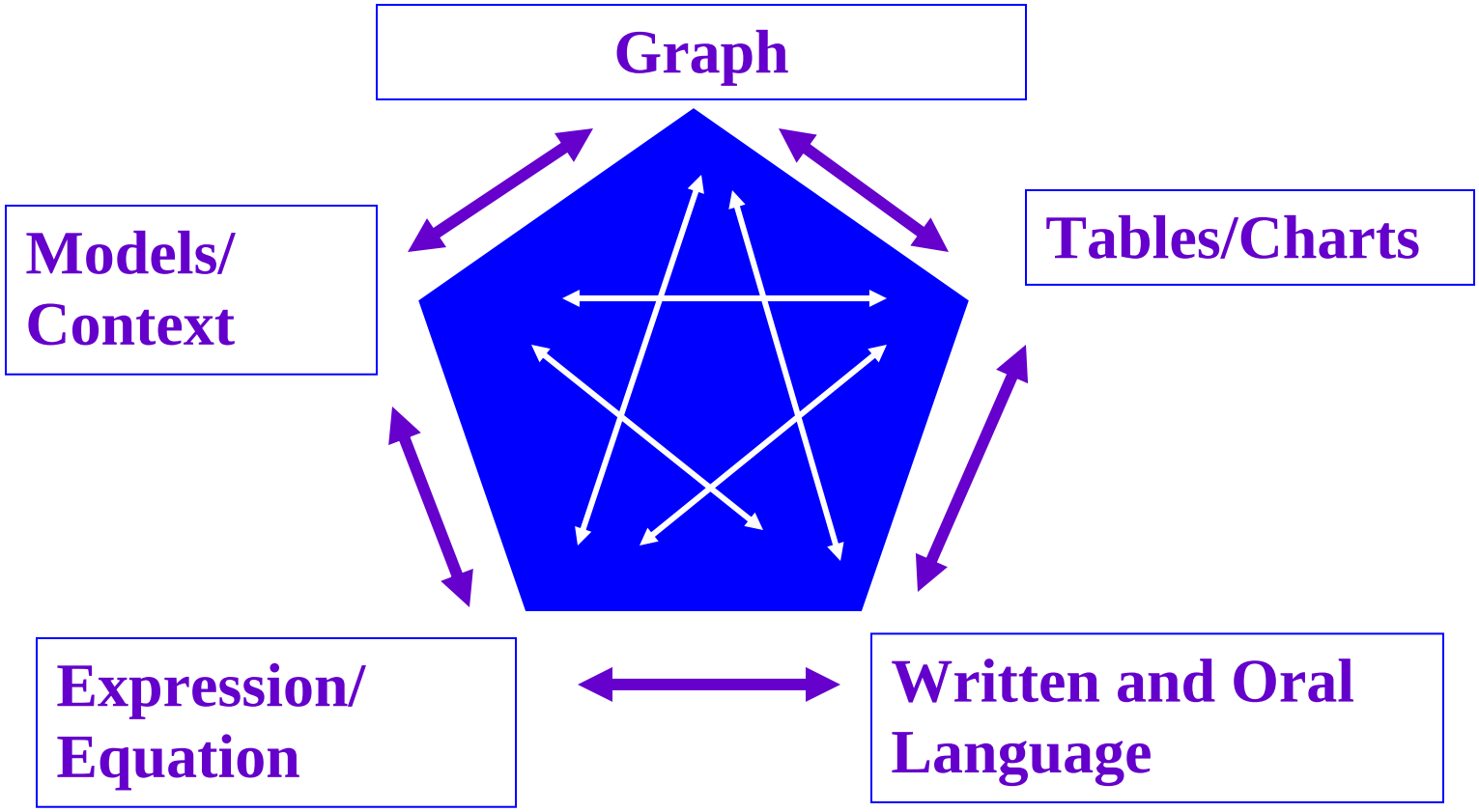
TM 17: Ten Stations Assignments

Continuation of Materials Activity 5: Data Collection Activity

Data Station (DS) Materials
DS: Balls - two types
DS: Circular Items - 8
DS: Crumpled paper - 10
DS: Cup
DS: M & M's - 25
DS: Masking Tape
DS: Meter sticks
DS: Pan balances - 2 or 3
DS: Peanut M & M's - 116
DS: Pennies - 100
DS: Plate
DS: Sandwich bags
DS: Skittles - 160
DS: Springs which easily stretch (or rubber bands)
DS: stop watch
DS: String - one meter long
DS: tape measures
DS: Tape measures
DS: Tiles (or dominoes) 100
DS: Waste baskets
DS: Weights - gram or ounce
DS: Weights to attach to string

TM- 13

Five Representations of a Function



TM- 14

Directions for Data Collection Stations

The materials available will determine which of the ten stations will be set up and how many of each station there will be. At a very minimum, three different stations need to be set up that represent linear relationships (bouncing ball, springs, tumbling tiles, ratio of D to C, balances); one station that represents a non linear relationship (skittles, pendulum); and two for the other types of relationships (M & M's, trashketball, and pennies).

Before beginning the data collection activity, brief descriptions and expectations for each station should be outlined. The presenter may choose to be very prescriptive regarding the instructions for each station. For instance, included can be the units to be used, specific types of graphs for each station including the labels and scale for each graph, and precise descriptions on how the participants are to measure and record the data. On the other hand, the presenter can allow the participants to do as they wish regarding all the measurements and recording procedures. The advantage of the former is that all students do the same things and the results are easy to compare. The advantage of the latter is that there are many more reasons to share results and compare and contrast the various representations of the data.

Following are the specific instructions the presenters could use for each of the ten stations along with some additional information.

Pendulums

Materials needed: Meter or yard sticks with one meter strings attached with weights on the end, stop watches to time periods, tape measures to measure the length of the strings.

Participants should measure five different lengths of pendulums and record the time for three swings of each length. The length should be recorded on the horizontal axis and the time on the vertical axis.

While the graph of length versus time of the pendulum for short lengths (less than one meter) is nearly linear, the graph is actually dependent on the square root of the length. Interestingly, the period does not depend on how far the string is displaced. For instance, if the pendulum was held ½ way to the meter stick, the period would be the same as if it were held ¾ of the way or all the way. Actually, it makes a slight difference due to friction and air currents.

Skittles Plate

Materials needed: Approximately 160 skittles in a cup and one plate for each set up.

Participants should place the number of the trial on the horizontal axis and the number of "S's" removed on the vertical axis. The resultant graph should approximate an exponential function where each successive trial should have about 0ne-half the number of "S's" as the previous one.

Pennies

Materials needed: Two sacks each containing about 50 pennies

Participants should create a histogram to record the dates of the coins rather than a bar graph. This allows more pennies in each section of the histogram.

Springs

Materials needed: Springs which easily stretch or rubber bands, tape measures, weights in ounces or grams, and sandwich bags to place the weights in. The participants should measure the amount the spring stretches rather than the length of the spring (rubber band). Measure the amount of stretch for five different weights and record the weight on the x-axis and the amount of stretch on the y-axis.

Bouncing Ball

Materials needed: Two different types of balls and tape measures

Participants should measure the height of the rebound for five different drop heights. Record the drop height on the x-axis and the rebound height on the y-axis.

Ratio of D to C

Materials needed: Seven or eight different circular items and tape measures.

Participants should measure five different circles and record the diameter on the x-axis and the circumference on the y-axis.

Trashketball

Materials needed: Waste baskets, 10 crumpled pieces of paper near each basket, and strips of tape on the floor 2 yards, 3 yards, and 4 yards from each waste basket.

Participants should toss ten pieces of paper from each line and record the number made.

Tumbling Tiles

Materials needed: 100 tiles or dominoes in each set and stop watches.

Participants should set up five different numbers of tiles and time their fall. Record number on the x-axis and the time on the y-axis.

M & M's

Materials needed: Twenty-four or twenty-five M & M's in each sack and circles on sheets of paper

The number of M & M's (24 or 25) depends on the goal of the activity. If the goal relates to equivalent fractions, the 24 should be used. If the goal relates to decimals or per cents, 25 should be used.

Balances

Materials needed: Two or three sets of pan balances, containers with 14, 26, 35, and 41 peanut M & M's in them with the number inside marked on the top of each container, and gram or ounce weights.

Participants should graph the number of M & M's on the x-axis and the weight on the y-axis.

Extensions:
Graphing calculators can be used with many of the stations. The data can be put into the Lists, L1 and L2, and then plotted using the 2nd y= button and graph. Determine the linear regression lines which fit the data. These can be accessed by 2nd List (STAT) then arrowing over to CALC, the pushing 5 or arrowing down to LinReg (ax+b), then inputting where the x-values are located (usually L1), "," then where the y-values are located (usually L2). The resulting equation can be examined and the meaning of the slope (a) and the intercept (b) discussed.

TM- 15

DATA COLLECTION STATIONS

Station # 1 – Pendulums
Make a pendulum by suspending the cord with a weight on it from the meter stick. Hold the weight ¾ of the way to the meter stick. Record the time for three complete swings (back and forth.) Record for various lengths of cord.

Station #2 – Skittles Plate
Spread the Skittles out so they cover the plate with a layer one Skittle thick. Remove all the candies with an S showing. Count and record that number. Set those aside. Pour the remaining ones from the plate into the glass. Shake the glass and pour those Skittles on the plate and again remove all the Skittles with the S showing. Continue this process until all the Skittles are removed. Graph the number of Ss showing versus the number of trials.

Station #3 – Pennies
Reach in one of the sacks and grab a handful of pennies. Record the sack number and the number of pennies for each year represented. Each partner should use a different sack.

Station #4 – Springs
Place various amounts of weight on the springs and record how much the spring stretches.

Station #5 – Bouncing Ball
Bounce a ball from various heights and record how high it rebounds. Repeat with a different ball.

Station #6 – Ratio of D to C
Measure various round objects. Compare the diameter of each object to the circumference.

Station #7 – Trashketball
Use a wadded up piece of paper. “Shoot” 10 shots from each of the 1, 2, and 3 point lines. Record the number you make from each place.

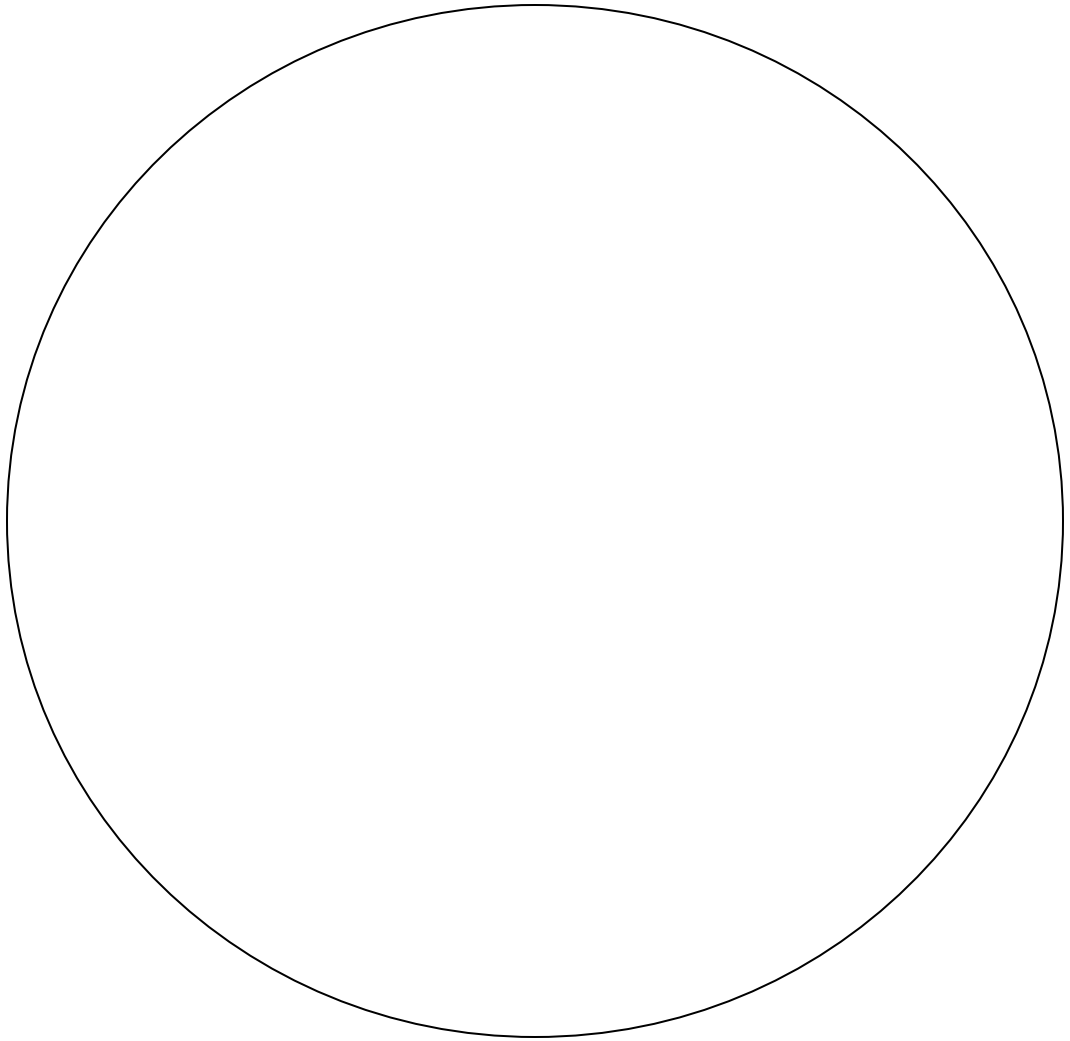
Station #8 – Tumbling Tiles
Set up tiles in a line and cause that line to tumble. Determine the time it takes for certain multiples of ten tiles to tumble.

Station #9 – M and M’s
Empty a bag of M & M’s. Place the M & M’s on the circle with like colors grouped together. Sketch in the wedges that represent each color. Write the name of the color in each wedge.

Station # 10 – Balances
Weigh the 4 numbered containers. Record the weight in ounces.

TM-16

M & M Mapping



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TEN STATIONS ASSIGNMENT

1. Gather data from at least three stations and put them in a readable chart or table.

2. Graph the data on graph paper.

3. Select one of three stations. Design a lesson you could present to your students using ideas from that station. Use the lesson template and write questions you could ask your students regarding the data from that station. Some questions should be "Reading Between" or "Beyond the Data."

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Activity 6: Problem-based Instructional Task Modeled

Time: 100 minutes (35 minutes-video; 20 minutes-sharing and discussion; 25 minutes -lesson planning; 20 minutes-carousel sharing)

Overview and Rationale

The video, *Trashketball* is available from the Show-Me Center at the University of Missouri (www.mmmproject.org). It presents a lesson where data is collected and organized. It provides the participants with a model of an effective teacher-led discussion related to a stem-and-leaf graph. Discussion of this video will allow participants to compare and contrast characteristics of teacher-led versus student-centered classes.

Connection to Other Activities and the Whole Day

While the data collection in the video is different than that in the Ten Stations activity, it shows several ways that data can be shared. It also points out the importance of asking questions and creating a classroom setting that encourages sharing. It presents a model for a lesson which can be contrasted and compared to Problem-Based Instructional Task lesson plans. This forms a nice transition to the activity where the participants are creating their own lesson plans at the end of this activity.

Conducting the Activity

- Participants watch the video and fill in the response form TM 18.
- Do a think, pair, share activity to share the ideas from the video.
- Summarize by highlighting the following points: (a) the important concepts of data collection and analysis which were presented (e.g. range, median, mode, clusters, stem and leaf, bar graph), (b) the way the teacher presented the need for organizing data, (c) the input that the students provided throughout the lesson, (d) how the teacher could have made the lesson more problem-based.
- Move to grade level groups of three or four.
- Examine PBIT lesson plan TM 19.
- Choose one of the stations just completed and write a lesson plan for a Problem-Based Instructional Task to be taught during the next few weeks.
- Make a poster highlighting key points of lesson TM 20.
- When completed, rotate posters around the groups. Allow three to four minutes for groups to process and respond to the posters. Each group uses their color marker to respond to allow for quick identification if questions arise from others.
- When the carousel is finished and the poster returns to the original group, give that group five minutes to process the comments/questions on their poster.
- These posters can be collected and used for assessment purposes.

Materials

TM 18: Response Form for Trashketball video
TM 19: Lesson Plan for Trashketball
TM 20: Poster Session with Carousel Sharing

- Modeling Middle School mathematics video, Trashketball
- Internet Connection for MMM

TM- 18

Response Form for *Trashketball*

Name _____

1. **What evidences of the Standards were present in this classroom?**

2. **What did you particularly like about how the teacher set up and carried out this activity?**

3. **What would you do differently in your classroom to better meet the needs of your students?**

TM- 19

PROBLEM-BASED INSTRUCTIONAL TASK LESSON PLAN

OBJECTIVE/BENCHMARK:
Data Collection and Data Analysis –
Select and use appropriate statistical methods to analyze data

TITLE: Springs

GRADE LEVEL/COURSE: Middle School – 6th

PRE-REQUISITE KNOWLEDGE:

NCTM STANDARD(S): (Shaded)

NCTM Content Standards →	Number & Operations	Algebra	Geometry	Measurement	Data Analysis & Probability
NCTM Process Standards →	Problem Solving	Reasoning & Proof	Communication	Connections	Representation

MATERIALS NEEDED:

Audio-visual:
Manipulatives/Materials: Modeling Middle School mathematics video, *Trashketball*
TM 15: Response Form for Trashketball video

Literature:
Technology/Software: Graphing calculator (optional)
Other:

MAIN LESSON DEVELOPMENT:

Launch: Have students work in groups of 3 or 4. Each group will need 2 different-sized springs, graph paper, and weights of various amounts, a plastic bag and a tape measure. Demonstrate how to use the spring and the weights and how to measure the stretch of the spring. "You need to graph the results on graph paper. What should be the independent variable? The dependent variable?"

Explore: Instruct the students to place various weights (at least 5 different ones) on each of two different-sized springs and measure how much the springs stretch in centimeters. Have the student record data in a table and graph the results.

Share: Share and discuss similarities and differences. Compare and contrast the types of graphs that were used. Why are some groups' measurements different than others? After classroom sharing, each student should summarize the findings in 3-5 sentences.

Summarize/Clarify: Select one summary per group to share with the class – emphasize the information that is important to convey (from the tables – proper lengths associated with the appropriate weight; from the graphs – appropriate labels, scales, and related points). Ask the students questions related to their graphs and charts (e.g., "What would be the stretch of the springs if you had 10 ounces? 20 ounces? 50 ounces? How much weight would cause the spring to stretch 7 cm? 10 cm?") Have the students write two questions about the data, two questions between the data, and two questions beyond the data.

Check for Understanding:

MODIFICATIONS/EXTENSIONS:

- **Modifications**
  - This activity is a Problem-Based Instructional Task that allows students from several ability levels to explore patterns

CHECKING FOR UNDERSTANDING (FORMATIVE ASSESSMENT)

- **What will you assess?** Select and use appropriate statistical methods to analyze data
- **How will you assess it?** Prepare a chart with data from a different spring. Have the students graph the data. Use some of the student questions, change the numbers and prepare for each group (or individual) to answer.

---------- (REFLECTION AFTER TEACHING THE LESSON) ----------

- **How did the students perform?**
- **How will you use this information to guide future instructional decisions?**

TM- 20 **Poster Session with Carousel Sharing**

Directions for Students:

When making your group's poster, you should:

- Write legibly
- Write the group member's names in small letters on the poster
- Write the problem and number, if applicable
- Identify the method of solution; show your work and explain briefly what you did
- Identify your answer
- If multiple methods are available, show them or describe them
- Write questions your group may have

When reading another group's poster, you must write something on the poster. You may:

- Write a solution, if none is given
- Agree with the solution shown, but show another method
- Give a different answer and show work
- Write a question
- Write a comment
- Answer a question posed

When your poster is returned to your group, you should:

- Look over and discuss what is written on the poster
- Summarize the solution methods
- Answer the questions posed

Activity 7: Closure

Time: 15 minutes

Overview and Rationale Assignments and Evaluations

Connections:
Share the connections of Every Student Counts (ESC) to Iowa Professional Development Model (IPDM) and Instructional Decision Making (IDM)

IPDM:
The IPDM is integrated into ESC in the following ways:

- Theory that supports the mathematics content and methodology discussed
- Demonstrations through modeling and/or videos on various components of Every Student Counts
- Practice through Problem-Based Instructional Tasks and Meaningful Distributed Practice
- Collaboration through working together and team meetings
- Implementation monitoring through implementation logs
- Evaluation, team meeting logs and implementation logs guiding design of future trainings.

IDM:
Every Student Counts acknowledges that schools need to support all students from the very talented to those who struggle. Using the terms from IDM, Every Student Counts trains teachers how to look at Core, Intensive and Supplemental instruction when creating Problem-Based Instructional Tasks and Meaningful Distributed Practice activities to address all students' needs in mathematics. Our lesson plan design reinforces this by asking the teacher to fill in: Check for Understanding, Modifications/Extensions, and Reflections after Teaching.

Conducting the Activity
Goals of the Day:
Review the connections and the goals of the day

- Understand patterns, relations, and functions
- Represent, analyze, and generalize patterns with tables, graphs, words, symbolic rules
- Relate and compare different representations for relationships
- Explore linear and nonlinear functions
- Talk about assignments and expectations

Materials
TM 21: Assignment

TM- 21

Assignments

- Collaborate with peer partner to refine data station PBIT lesson plan, teach the lesson and reflect on student understanding. Bring five copies of lesson plan to share.

- Bring selected student work (one representing a low level student response, one middle and one high level student response) from data station PBIT. Bring five copies of each student response level.

- Read about connections (PSSM pp. 274 - 279 and pp. 64 – 66)

- Read Teacher Story 5 (Green problem solving book, pp. 219 – 225)

Every Student Counts

Participant Feedback **Date:**

What is your primary role?

_____AEA Team _____Urban 8 District Team

What were your key learnings from this session?

What questions do you have about the information and content presented and discussed during this session?

What considerations and concerns do you have about your individual use and follow-through of the information presented and discussed this session?

What considerations and concerns do you have about your team use and follow-through of information presented and discussed this session?